It will be apparent to those skilled in the art that the present disclosure is merely representative of the basic inventive concepts set forth in the following claims. For example, other variations will be recognized, such as biasing the emitter membrane by coupling a back plate directly against the emitter membrane to pinch the membrane at the small throat opening and isolate the membrane from adjacent acoustic horns within the plate support member. Furthermore, the emitter membrane may perform the additional step of actively driving the generation of compression waves within the acoustic horn, as opposed to passive or inductive methods generally described in this disclosure.

CLAIMS

We claim:

1. A sonic emitter array with enhanced emitter-to-air acoustic coupling, said emitter comprising:

a plate support member having opposing first and second faces separated by an intermediate plate body, said plate body having a plurality of conduits configured as an array of acoustic horns, each horn having a small throat opening at the first face and an intermediate horn section which diverges to a broad mouth opening at the second face;

an emitter membrane positioned in direct contact with the first face and extending across the small throat openings;

biasing means operable with respect to the emitter membrane for (i) applying tension to the membrane extending across the throat openings and (ii) displacing the membrane into a non-planar configuration;

means for applying a sonic frequency to the membrane for propagation through the intermediate horn section and out the broad mouth opening at the second face.

2. A sonic emitter array as defined in claim 1, further comprising a back plate positioned behind the membrane and adjacent the small throat openings, said back plate including contact structure for clamping the membrane in fixed position around the small throat opening such that vibrational energy is not transferred through the membrane to adjacent horns.

3. A sonic emitter array as defined in claim 2, wherein the back plate includes protruding structure aligned with each small throat opening, said protruding structure providing means for displacing the membrane into the non-planar configuration.

4. A sonic emitter array as defined in claim 3, wherein the protruding structure comprises a convex bump having a size approximately equal to the small throat opening, said back plate including means for developing a gap between the convex bump and the membrane to allow vibrational displacement of the membrane when activated with the sonic frequency without contact with the convex bump.

5. A sonic emitter array as defined in claim 4, wherein the means for developing the gap between the convex bump and the membrane comprises structure for supplying an electrostatic charge operable to repel the membrane from the bump during operation.

6. A sonic emitter array as defined in claim 4, wherein the means for developing the gap between the convex bump and the membrane comprises structure for supplying a differential air pressure operable to maintain the gap during operation.

7. A sonic emitter array as defined in claim 4, wherein the means for developing the gap between the convex bump and the membrane comprises structure for supplying a magnetic force operable to repel the membrane from the bump during operation.

8. A sonic emitter array as defined in claim 4, wherein the means for developing the gap between the convex bump and the membrane comprises a spacer ring positioned between the membrane and the back plate, said bump being disposed in alignment with a central opening of the spacer ring.

9. A sonic emitter array as defined in claim 2, wherein the means for developing the gap between the back plate and the membrane comprises protruding structure having an apex in contact with a central portion of the membrane to physically displace the membrane from the back plate during operation, said contact of the apex with the membrane being sufficiently nominal to allow transfer of the sonic frequency to the membrane as an emitter.

10. A sonic emitter array as defined in claim 3, wherein the protruding structure comprises a conical structure having an apex in contact with a central portion of the membrane to physically displace the membrane from the back plate during operation, said contact of the apex with the membrane being sufficiently nominal to allow transfer of the sonic frequency to the membrane as an emitter.

11. A sonic emitter array as defined in claim 3, wherein the protruding structure comprises a pin structure having an apex in contact with a central portion of the membrane to physically displace

the membrane from the back plate during operation, said contact of the apex with the membrane being sufficiently nominal to allow transfer of the sonic frequency to the membrane as an emitter.

12. A sonic emitter array as defined in claim 1, wherein said plate support member is comprised of an electrically conductive material which is capable of carrying a voltage for supplying the sonic frequency to the membrane.

13. A sonic emitter array as defined in claim 1, wherein the membrane comprises a PVDF material responsive to voltage changes to generate physical vibrations at the small throat opening as a sonic emitter.

14. A sonic emitter array as defined in claim 13, wherein the means for providing sonic frequency to the membrane comprises a voltage signal source coupled to the membrane and operable to supply a variable signal which is converted by the PVDF material of the membrane into compression waves.

15. A sonic emitter array as defined in claim 14, wherein the signal source comprises an ultrasonic signal generator which is coupled to an amplitude modulator for mixing audio frequencies with ultrasonic frequencies to develop an ultrasonic wave form having at least one sideband corresponding to the audio frequencies, said sonic emitter providing ultrasonic compression waves propagating from the horn array within a surrounding air environment which

decouples the audio frequencies to generate audio output as part of an acoustic heterodyne speaker system.

16. A sonic emitter array as defined in claim 1, wherein the membrane comprises a dielectric material responsive to electrostatic voltage changes to generate physical vibrations at the small throat opening as an electrostatic sonic emitter, said back plate comprising a conductive medium capable of driving the electrostatic sonic emitter at the sonic frequencies.

17. A sonic emitter array as defined in claim 17, wherein the means for providing sonic frequency to the membrane comprises a voltage signal source coupled to the back plate and operable to supply a variable signal which is converted by the dielectric material of the membrane into compression waves.

18. A sonic emitter array as defined in claim 17, wherein the signal source comprises an ultrasonic signal generator which is coupled to an amplitude modulator for mixing audio frequencies with ultrasonic frequencies to develop an ultrasonic wave form having at least one sideband corresponding to the audio frequencies, said sonic emitter providing ultrasonic compression waves propagating from the horn array within a surrounding air environment which decouples the audio frequencies to generate audio output as part of an acoustic heterodyne speaker system.

19. A sonic emitter array as defined in claim 1, wherein the plate support member comprises circular plate.

20. A sonic emitter array as defined in claim 1, wherein plate support member includes an emitter array having a diameter of at least three inches.

21. A sonic emitter array as defined in claim 19, wherein the circular plate is planar in configuration.

22. A sonic emitter array as defined in claim 19, wherein the circular plate is concave in configuration, having a radius of curvature selected to minimize phase misalignment at a listener location at a predetermined distance from the emitter array.

23. A sonic emitter array as defined in claim 1, wherein the array of horns comprise conduits which are molded to a desired shape within the plate support member for acoustic coupling of ultrasonic frequencies to surrounding air.

24. A sonic emitter array as defined in claim 1, wherein the array of horns comprise conduits which are machined to a desired shape within the plate support member for acoustic coupling of ultrasonic frequencies to surrounding air.

25. A sonic emitter array as defined in claim 1, wherein the membrane is preformed with an array of dimples positioned for alignment with the small throat openings of the horn array to provide the non-planar configuration as part of the biasing means.

26. A sonic emitter array as defined in claim 25, wherein the array of dimples are uniform in size and acoustic response to generate a substantially common wave front at the second face of the plate support member.

27. A method for developing a high efficiency acoustic coupling device for coupling ultrasonic emitters to a surrounding air environment, said method comprising the steps of:

a) attaching an emitter membrane at a small throat opening of an acoustic horn;

b) applying sonic frequencies to the emitter membrane to generate sonic compression waves at the small throat opening of the acoustic horn; and

c) propagating the sonic compression wave through the acoustic horn for enhanced air coupling at a broad mouth of the horn.

28. A method as defined in claim 27, further comprising the step of forming an array of acoustic horns by preparing a plate support member having opposing first and second faces separated by an intermediate plate body, said plate body having a plurality of conduits configured as an array of acoustic horns, each horn having a small throat opening at the first face and an intermediate horn section which diverges to a broad mouth opening at the second face;

positioning the emitter membrane in direct contact with the first face and extending across the small throat openings;

biasing the emitter membrane for (i) applying tension to the emitter membrane extending across the throat openings and (ii) displacing the emitter membrane into a non-planar configuration; and

applying a sonic frequency to the emitter membrane for propagation through the intermediate horn section and out the broad mouth opening at the second face.

29. A method as defined in claim 28, wherein the biasing step is accomplished in part by coupling a back plate against the emitter membrane to pinch the membrane at the small throat opening and isolating the emitter membrane from adjacent acoustic horns within the plate support member.

30. A method as defined in claim 28, wherein the emitter membrane performs the additional step of actively driving the generation of compression waves within the acoustic horn.